Part 1. Report Cover

Report Number: **D003**

Title: Performance Oriented Packaging Testing of an
MS27683 Removable Head Drum, 30-Gallon, with
1-Gallon, Friction Plug (Lid), Round, Metal Can
(Quantity of 4) for Liquids, Packing Group I (All Modes)

Responsible Individual: R. Craig Webb, Code 512, DSN 744-4142 or Commercial (360)396-4142

Performing Activity: Naval Undersea Warfare Center Division, Keyport
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Original Report Date: July 2001

Report Type: Final

Keyport Report Number: 01KPT07

DTIC Distribution: N/A

Requesting Organization:

Defense Logistics Agency
Defense Distribution Center
ATTN: DDC-TO
2001 Mission Drive
New Cumberland, PA 17170-5000

Requesting Organization's Reference(s):

DDC memo of 06 Dec 00, Subj: Performance Oriented Tests to be Performed in 2001

Part 2. Data Sheet

A. Exterior Shipping Container

UN Type:	Steel, Removable Head Drum
UN Code:	1A2
Specification Number(s):	MIL-D-6054, MS-27683-7, 30-Gallon Capacity NSN 8110-00-866-1728
Container Supplier:	N/A Cage 81349/96906
Date of Manufacture:	2000
Material:	Steel
Container Dimensions:	18.25 in. (268mm) Dia. x 27 in. (502 mm) high (ID)
Closure (Type/Method):	Locking ring assembly, nut, bolt, rubber gasket
Absorbent Material:	Vermiculite, Fine Grain, Grace Zonolite Construction Products, NSN 8135-01-324-2664

(Note: Additional testing was done with Absorbent GP and A-900. The cushioning effect was similar to vermiculite and testing results were the same. However, scientific study results of the absorbent qualities of these two material types were not available to the testing lab.)

B. Inner Packaging of Combination Packaging: N/R

C. Actual Product: Not Used

D.

Test Product:	Water
UN Packaging Group:	I
Physical State:	Liquid
Amount per Container:	9 lbs.
Test Weight:	111.7 lbs. (50.7 kg)
Density/Specific Gravity:	N/A
Drop Height:	71 in. (1.8 m)
Stacking Weight/Force:	1000 lbs. (455 kg)

Additional Description:

1. Line the drum with 4 Mil Polyethylene bag.
2. Place 4 inches of vermiculite in the bottom of the drum.
3. Place two paint cans on the vermiculite separated from each other and the sides of the drum by 1.75 inches.
4. Add another 2 inches of vermiculite on top of the cans making a firm pack by tamping the vermiculite around and on top of the cans.
5. Place a fiberboard separator on top of the vermiculite and add another two inches of vermiculite.
6. Place two more paint cans as described in step 3 above then make a firm pack by tamping the vermiculite around and on top of the cans covering

them with 4 inches of vermiculite.

7. Twist the 4 Mil bag and tape closed. (Closure IAW MIL-D-6054F)
8. The quantities of absorbent material DO meet the guidelines for absorbent material outlined in AFJMAN 24-204/ TM 38-250/NAVSUP PUB 505/MCO P4030.19F/DLAM 4145.3, Preparing Hazardous Materials for Military Air Shipments.

Part 3. Test Applicability:

A. Based on the drop height, computed stacking weight, and internal pressure maintenance, this test report is applicable for all modes of transportation including air and surface means (road, rail, and water) when the liquid hazardous substance intended for containment by the tested packaging is as described in this report. Transportation by commercial (cargo and passenger) or military air is as permitted by regulation for the hazardous item. The appropriate packaging paragraph for the lading applies.

B. Pass/fail conclusions were based on the particular drum specimens, test loads, and the limited quantities submitted for test. Extrapolation to other materials, other manufacturers, other applications, different inner packagings, container sizes, or lesser inner quantities is the responsibility of the packaging design agency or applicable higher headquarters. Extrapolation of test results based on less than the minimum recommended number of test specimens is also the responsibility of the packaging design agency or applicable higher headquarters.

C. Reference to specification materials has been made based either on the information provided by the requester, the manufacturer, or the markings printed on, attached to, or embossed on the packaging. It was not possible to identify the exact composition of the drum construction materials.

D. Testing was performed per Title 49 Code of Federal Regulations except as noted in this report.

E. Performance testing was undertaken and completed at the request of an agency responsible for the shipment of dangerous goods. The successful completion of required performance tests does not, by itself, authorize the marking and transportation of the dangerous goods. Applicable modal regulations should be consulted concerning the relationship of performance testing completed and the dangerous goods.

F. Required performance tests are intended to evaluate the performance of the packaging components. The criteria used to evaluate packaging performance is whether the contents of the packaging are retained within the outer packaging, should damage to the outer packaging occur, and secondly, if any inner packaging of hazardous materials leaks, ruptures, or is

damaged so as to affect transportation safety. The successful completion of the required tests does not ensure the undamaged delivery or survivability of the actual commodity/item.

G. Before a configuration can be certified by the person(s) authorizing shipment, the appropriate packaging for the particular hazardous lading and mode of transportation must be determined, and the item(s) must be prepared for shipment per applicable regulations. The chosen configuration must have been performance tested in accordance with the size, the shape, and the weight constraints posed by configuration to be certified. The testing reported herein should not be construed as blanket certification of any configuration that simply uses the performance tested drum. Packaging paragraphs apply.

Part 4. Tests Required:

Packing Group I (greater danger) testing was requested for the above stated configuration. This configuration is intended to be applicable to a large assortment of liquid products contained in metal drums. These tests are designed to simulate the hydrostatic pressure, static loading, shock, and vibration a package (configuration) may encounter when being shipped worldwide by air, truck, rail, or ocean going transport. The order of testing was hydrostatic pressure, static loading, vibration, then drop testing.

A. Hydrostatic Pressure Test:

The hydrostatic pressure test is conducted on metal drums intended for combination packagings used for air transportation.

B. Stacking Test:

Three containers are required, one test per container. Compression by a top load is calculated to simulate a stack of height of 3 meters, maintained for 24 hours, followed by testing the container stability by placing two loaded containers on top of the tested container for at least 1 hour.

C. Vibration Test:

Three sample packagings must be filled and closed as for shipment. The samples must be placed on a vibrating platform designed to simulate actual vibrations encountered during transportation. The packages should be constrained horizontally to prevent them from falling off the platform, but must be left free to move vertically, and bounce and rotate.

D. Drop Test:

Six drops, requiring 6 sample containers. First drop (using 3 containers), the package must strike the target diagonally on the chime or, if the packaging has no chime, on a circumferential seam or edge. Second drop (using the other 3 samples), the package must strike the target on the weakest part not tested by the first drop, for example a closure or for some cylindrical drums, the welded longitudinal seam of the drum body. The drop height shall be appropriated or the packaging group of the commodity. The container shall strike the target, which shall be a rigid, non-resilient, flat, horizontal surface. For other than flat drops, the center of gravity shall be vertically over the point of impact.

Part 5. Applicable Packing Group Test Requirements:

A. Hydrostatic Pressure Test:

Three test samples are required for hydrostatic testing. Each container is individually tested for 5 minutes at pressure in accordance with 49 CFR 178.605

B. Stacking Test:

Apply the calculated static weight using a constant load evenly over the entire container.
Stacking Weight/Dynamic Compression Force: Ref. 49 CFR 178.606

Liquids -- $A = (n - 1) [w + (s) (v) (8.3) (9.8)] (c)$

Where:
A = applied load in pounds
n = minimum number of containers that when stacked reach a height of 3 m (round up to next integer).
s = specific gravity of lading
w = maximum weight of one empty container in pounds
v = actual capacity of container (rated capacity + outage) in gallons
8.3 corresponds to the weight (lbs.) of 1 gallon of water
.98 corresponds to maximum fill (98% max. capacity)
c = either 1.5 (the compensation factor that converts the static load of the stacking test into a load suitable for dynamic compression testing), or 1.0 (static top load)

Using this formula the calculated stacking weight for the three different specific gravity numbers (1.2, 1.8, 2.7) are 460 lbs., 538 lbs., and 655 lbs. respectively. The actual stacking weight used was 1000 lbs.

Note: This test assumes similar weight containers stacked on top of the test sample. This may or may not be a valid assumption. This calculation also only provides a minimum weight. Consideration should be given to what will actually be experienced in the transportation cycle.

C. Vibration:

The test shall be performed for 1 hour at a frequency that causes the package to be raised from the vibrating platform to such a degree that a piece of material approximately 1/16 inch (0.2 cm) thick can be passed between the bottom of the package and the platform. The vibrating platform shall have a vertical double-amplitude (peak-to-peak) displacement of one-inch (2.54 cm). Test shall be performed in accordance to 49 CFR 173 Subpart B, Appendix C and 49 CFR 178.

D. Drop Test:

Solids and liquids, if the test is performed with the actual contents to be carried, or with another substance having essentially the same characteristics, or for liquids if the test is performed with water and the intended contents has a density of less than 1.2 g/cm^3 (specific gravity less than 1.2) the drop height shall be:

Packing Group	Drop Height
I	1.8 m (70.9 inches)
II	1.2 m (47.2 inches)
III	0.8 m (31.5 inches)

Where the test sample doesn't contain the intended contents and its specific gravity is greater than 1.2, then obtain the required drop height in meters by calculating the following with product density (d):

Packing Group	Drop Height
I	(d) x 1.5 m or (d x 59.1 inches)
II	(d) x 1.0 m or (d x 39.4 inches)
III	(d) x .67 m or (d x 26.4 inches)

Round the drop height up to the first decimal.

Part 6. Criteria for Passing Tests:

A. Hydrostatic Pressure Test:

A package passes the hydrostatic test if, for each sample there is no leakage from the package.

B. Stacking Test:

No test sample shall leak. Composite and combination containers shall not exhibit leakage of the filling substance from the inner receptacle or container. No test sample shall show any distortion liable to reduce its strength, cause stacking instability, or cause damage to internal container components likely to reduce transportation safety. The outer packaging must meet the stacking test requirements when empty in order to meet the variation 2 conditions.

C. Vibration Test:

Each packaging must be able to withstand the vibration test procedure without rupture or leakage. Immediately after testing each sample shall be turned on its side and observed for evidence of leakage. No test sample shall show any deterioration, which could adversely affect transportation safety, result in possible discharge of contents or reduce packaging strength.

D. Drop Test:

There must be no damage to the outer packaging likely to adversely affect safety during transport, and there is no leakage of the filling substance from the inner packaging.

Part 7. Test Results and Discussion:

A. Hydrostatic Pressure Test: PASS

Internal Pressure/Hydrostatic Pressure test: See 49 CFR 178.605

___ N/A (surface only; solids); 49 CFR 178.605(a)

* __ 250 kPa (36 psi) for _X_ 5 ___ 30 min.; 49 CFR 178.605(d)
49 CFR 173.27(c) (3) (ii)

_X_ 100 kPa (15 psi) for _X_ 5 ___ 30 min.; 49 CFR 178.605(d) (2)
49 CFR 173.27(c) (3) (ii)

_X_ 95 kPa (14 psi) for ___ 5 ___ 30 min.; 49 CFR 173.27(c) (2) (i)

_X_ 80 kPa (12 psi) for ___ 5 ___ 30 min.; 49 CFR 173.27(c) (3) (ii)

_X_ 75 kPa (11 psi) for _X_ 5 ___ 30 min.; 49 CFR 173.27(c) (2) (i)

* Packing Group I hydrostatic pressure testing was requested to 150 kPa. All three test samples did maintain 150 kPa for the required full five minutes. In order to accomplish this the rubber gasket was brushed (both sides) with talcum powder (NSN 8510-817-0295) and the locking ring was tapped repeatedly during tightening with a rubber mallet until the ring closed around the cover, leaving a gap of ¼ to 3/8 inch between the ends of the ring. It should be noted that the ends of the container bulged significantly at this pressure. The three drums were tested to their failure point, 214 kPa (31 psi), 200 kPa (29 psi), and 186 kPa (27 psi) all short of the 250 kPa (36 psi) for Packing Group I. Three drums do not represent a statistically

significant sample which brings into question the validity of using this data to designate these 30 gallon drums as acceptable for packing group I status.

B. Stacking Test: PASS

Three empty drums were stacked with 1000 lbs. and maintained in that condition for a period of 24 hours with no visible damage or adverse effects. The same three drums were then packed as described in Part 2 and again stacked with 1000 lbs. for a period of 24 hours with no visible damage or adverse effects.

C. Vibration Test: PASS

The three drums packed as described above were subjected to the vibration test. Each was tested on a vibration table, which was set a 1- inch vertical double amplitude (peak-to-peak) displacement, at a frequency such that the drum was raised from the platform. The distance was measured using a 1/16-inch feeler gage. The frequency was set such that the feeler gage could be passed between the bottom of the package and the table surface. There was no damage or adverse effects in evidence to the drum or its contents.

D. Drop Test: PASS

One drum, which was reused from both the stack and vibration tests, was dropped 71 inches (1.8 m) onto a two-inch thick steel impact plate. This drum was subjected to five drops as follows: diagonally onto the top chime, diagonally onto the bottom chime, flat onto the welded longitudinal seam, flat onto the bottom, and finally flat onto the top. There was no damage to the test loads. Except for minor denting of the impacted area, no adverse results were noted.

The decision to use the same container (configuration) for all drops was based on the relatively minimal damage demonstrated during previous testing. Five drops per drum exceeds 49 CFR 178.603 requirements, as well as both UN and ASTM recommendations (i.e., one drop diagonally onto a chime, one drop on the next weakest part, repeated using six samples total). The use of one configuration for multiple tests and drops is DOD policy as stated in draft regulation DLAR 4145.41/AR 700-143/AFR 71-5/NAVSUPINST 4030.55/MCO 4030.40, Packaging of Hazardous Material, the use of which was directed by MMDOS Letter 94-1 (same title), and its use extended by agreement during the DOD Performance Oriented Packaging Working Group meeting, Richmond, VA, 19-21 Sep 95.

Part 8. References:

A. Title 49 Code of Federal Regulations
B. International Air Transportation Association Dangerous Goods Regulations
C. ASTM D 4919, Specification for Testing of Hazardous Materials Packagings

D. ASTM D 999, Standard Method for Vibration Testing of Shipping Containers

E. DLAD 4145.41/AR 700-143/AFJI 24-201/NAVSUPINST 4030.55A/MCO 4030.40A, Packaging of Hazardous Materials

Part 9. Distribution List:

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